The NASA "Why?" Files
The Case of the Barking Dogs

Program 2 in the 2000–2001 Series

Educator's Guide	
Teachers & Students	Grades 3-5

EP-2000-09-20-LaRC

The NASA "Why?" Files

whyfiles.larc.nasa.gov

Educator's Guide	
Teachers & Students	Grades 3-5

EP-2000-09-20-LaRC

Production of the NASA "Why?" Files is made possible by the generous support provided by AIAA Foundation; Busch Gardens, Williamsburg; Hampton City Public Schools; and the NASA Langley Research Center's Learning Technology Project and Aerospace Vehicle Systems Technology Program Office.

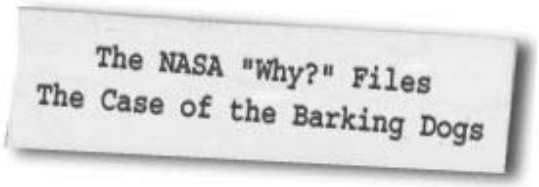
Writers and Teacher Advisors:
Shannon Ricles and
Sandra Fraebel

Editors: Cheryl Keeton, Bill Williams, Susan Hurd

Graphic Designer:
Heather Grimstead

The American Institute of Aeronautics and Astronautics (AIAA) provides classroom mentors to educators who register for the NASA "Why?" Files. Every effort will be made to match a teacher with an AIAA member who will mentor the teacher either in person or by e-mail. To request a mentor, e-mail nasawhyfiles@aiaa.org or call Lisa Bacon at (703) 264-7527.

Contact the AIAA to get a classroom mentor at ***nasaconnect@aiaa.org****.*



Index

Program Overview 4
National Math Standards 5
National Science Standards 6
National Educational Technology Standards .7

Part 1 **Segment 1**
Segment Overview 9
Objectives 10
Vocabulary 10
Video Component 11
Careers 11
Resources 12
Activities and Worksheets 13

Part 2 **Segment 2**
Segment Overview 25
Objectives 26
Vocabulary 26
Video Component 27
Careers 27
Resources 28
Activities and Worksheets 29

Part 3 **Segment 3**
Segment Overview 39
Objectives 40
Vocabulary 40
Video Component 41
Careers 41
Resources 41
Activities and Worksheets 42

Part 4 **Segment 4**
Segment Overview 51
Objectives 52
Vocabulary 52
Video Component 52
Careers 53
Resources 53
Activities and Worksheets 54

Program Overview

In *The Case of the Barking Dogs*, the tree house detectives have yet another mystery to solve. Many of the neighborhoods in Big City are experiencing a problem with their pooches barking late at night and early in the morning. The barking is even affecting some of the tree house detectives. They have a big test soon and they need to get some sleep!

The tree house detectives visit their friend Dr. D, a retired science professor, for advise on where to start their investigation. With his direction, the tree house detectives go on many excursions to speak with various NASA Researchers, an audiologist, a veterinarian, and even their classroom teachers to get help solving the case. Along the way, they learn more about sound: what it is, how it is transmitted, and how people and animals hear. With a few clues from the local news station, KSNN (Kids Science News Network), the tree house detectives are able to use scientific inquiry and the scientific method to solve the mystery.

Tune in to see what is causing the neighborhood dogs to bark. Use your scientific investigation skills and "sound" reasoning to uncover the hilariously funny ending to the mystery!

National Math Standards (grades 3–5)

Standard	Segment 1	2	3	4
Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems		✖	✖	
Understand meanings of operations and how they relate to one another		✖	✖	
Compute fluently and make reasonable estimates		✖	✖	
Algebra				
Represent and analyze mathematical situations and structures using algebraic symbols		✖		
Use mathematical models to represent and understand quantitative relationships		✖		
Analyze change in various contexts		✖		
Geometry				
Specify location and describe spatial relationships using coordinate geometry and other representational systems				✖
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement		✖	✖	✖
Apply appropriate techniques, tools, and formulas to determine measurements		✖	✖	✖
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them	✖			
Select and use appropriate statistical methods to analyze data	✖	✖		
Connections				
Recognize and use connections among mathematical ideas		✖		
Recognize and apply mathematics in contexts outside of mathematics				✖
Representation				
Create and use representations to organize, record, and communicate mathematical ideas	✖	✖		✖
Use representations to model and interpret physical, social, and mathematical phenomena				✖

National Science Standards (grades k–4)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, orders, and organization	✖	✖	✖	✖
Evidence, models, and explanations		✖	✖	✖
Change, constancy, and measurement		✖	✖	
Science and Inquiry (A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understanding about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Properties of objects and materials			✖	✖
Position and motion of objects	✖	✖	✖	✖
Life Science (C)				
Characteristics of organisms		✖		
Organisms and their environments	✖	✖	✖	✖
Science and Technology (E)				
Abilities of technological design	✖	✖	✖	✖
Understanding about science and technology.	✖	✖	✖	✖
Science in Personal and Social Perspective (F)				
Changes in environment	✖	✖	✖	✖
Science and technology in local challenges		✖		
History and Nature of Science (G)				
Science as a human endeavor	✖	✖	✖	✖

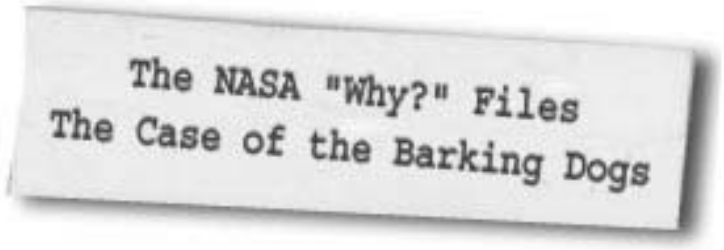
National Science Standards (grades 5–8)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, order, and organization	✖	✖	✖	✖
Evidence, models, and explanations		✖	✖	
Change, constancy, and measurement		✖	✖	
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understandings about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Motion and forces			✖	✖
Transfer of energy	✖	✖	✖	✖
Life Science (C)				
Regulation and behavior	✖	✖	✖	✖
Science and Technology (E)				
Abilities of technological design	✖	✖	✖	✖
Understanding about science and technology	✖	✖	✖	✖
Science in Personal and Social Perspectives (F)				
Risks and benefits		✖		
Science and technology in society	✖	✖	✖	✖
History and Nature of Science (G)				
Science as a human endeavor	✖	✖	✖	✖
Nature of science		✖	✖	✖

National Educational Technology Standards (grades 3–5)

Performance Indicators for Technology-Literate Students

Standard	Segment 1	2	3	4
Basic Operations and Concepts				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Technology Communication Tools				
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	✖			✖
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖		✖
Technology Research Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖			✖



Segment 1

KSNN (Kids Science News Network) is encouraging dog owners to bring in their pooches at night so Big City residents can get some sleep. Several friends, known as the tree house detectives, are wondering what is causing the dogs in the neighborhood to bark. The tree house detectives are excited to begin their next case, *The Case of the Barking Dogs*. The children visit their neighbor, a retired science professor, who reviews the methods of science and emphasizes the importance of using the Scientific Method to solve problems. The children use the NASA "Why?" Files' web site to gather research on sound and visit their local museum to learn about vibrations and frequency. They use the Internet to send e-mails to local residents to determine which neighbors are having difficulty with barking dogs. A NASA Langley Research Center researcher shows the tree house detectives how to collect and analyze their data.

Objectives

Students will be able to

- learn the processes involved in solving problems by using the methods of science.
- make observations and inferences from hands-on experience.
- solve a problem by using the methods of science.
- analyze data by using a matrix board.
- discover how sound is created by performing experiments with vibration and frequency.
- explore the physics of sound such as vibration and pitch.
- discover how musical instruments create sound.
- discover and learn more about possible career choices by viewing the video and researching other careers.

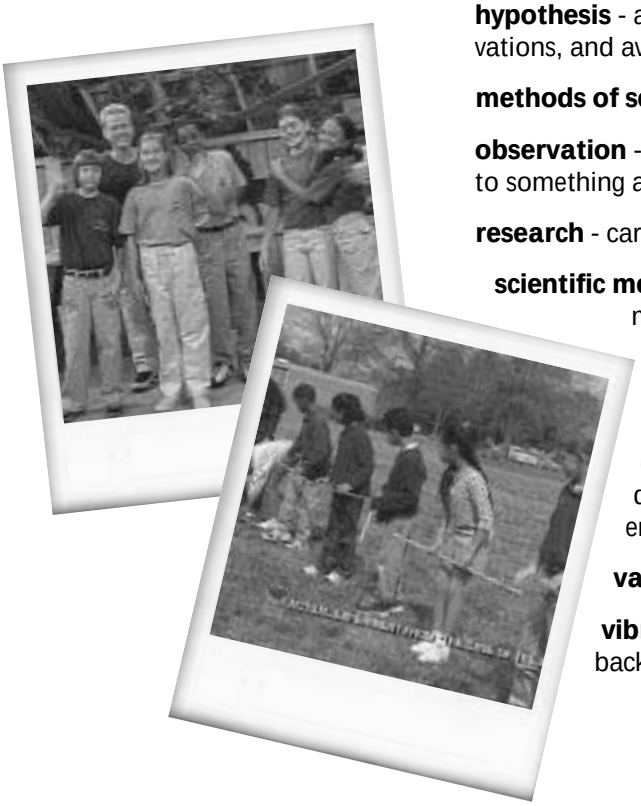
Vocabulary

conclusion - a judgment or decision reached after analyzing data

data - factual information, especially information organized for analysis or for making decisions

frequency - the number of vibrations per given amount of time

hypothesis - a testable prediction for a problem based on research, observations, and available data



methods of science - processes used in solving problems

observation - the act of systematically observing or paying careful attention to something and noting or recording what was observed

research - careful study or investigation of something

scientific method - the problem-solving procedures used by scientists that may or may not include the following basic steps: define the problem, make a hypothesis, test the hypothesis, analyze the results, and draw conclusions

scientist - a person who has special training and expertise/knowledge in the observation, identification, description, experimental investigation, and explanation of scientific facts or occurrences

variables - in an experiment, any factor that can change

vibrations - a rapid linear motion of a particle or elastic solid; a back and forth wave movement of sound

Video Component (15 min)

Before Viewing

Introduce the video to the students by reading its title and synopsis. Ask students to predict what they think might be causing the dogs to bark.

For students to better relate to the video and the terminology introduced in the first segment, the teacher may wish to perform the following pre-activities before viewing.

1. Introduce problem solving by discussing with the students the different ways that they solve problems in their daily lives
2. Introduce the scientific method as a problem-solving process/tool that scientists use to solve problems. Emphasize that the scientific method is not a step-by-step process but rather an ongoing process of gathering information, obtaining data, formulating and reformulating a hypothesis, and drawing conclusions. ***Note:*** *Many science educators today prefer the term "methods of science."*
3. From the web, download the Scientific Method Handout and use it to acquaint students with terminology and processes. This handout has a brief description of each part of the scientific method.
4. The Scientific Method Worksheet (p.15), for all grade levels, may be used as a practice sheet or a written assessment of the students' understanding of the scientific method.
5. To familiarize students with the methods of science, choose an experiment from the guide (Colorful Carnations, p. 16) or from the web (Color Mixing) for the students to perform. Have students write the steps of the experiment and then perform the procedure. We suggest this be a teacher-lead activity with a discussion of each step and an explanation of its relationship and relativity to the methods of science. Draw conclusions.
6. Make a predictions chart. Accept all answers, but help students to narrow focus if necessary. Do a K-W-L (What you **K**now, what you **W**ant to know, and what you have **L**earned) for various predictions. See the Matix Board Chart (p. 20).

After Viewing the Video

1. Discuss the questions that are asked at the end of the first segment.
   - Will the dogs continue to bark?
   - Are the tree house detectives asking the right questions?
   - Will the scientific method solve the problem?
2. Make a display of the Methods of Science Board (p. 14). Refer to the chart as the students go through the scientific method to reinforce that it is not a step-by-step process but rather an interdependent relationship.
3. Choose from the activities in this packet (p. 14-23) to help reinforce the concepts and objectives emphasized in this segment.

Careers

Museum Curator
Professor or Teacher
Scientist
Reporter
Computer Technician
Research Analyst
Detective

Resources

Web Sites

NASA "Why?" Files Web Site
Official web site of the NASA "Why?" Files. Student, teacher, and parent friendly.
http://whyfiles.larc.nasa.gov

Books and Other References

Cole, Joanna: *The Magic School Bus Gets Programmed, A Book About Computers.* NY: Scholastic, Inc. (1999), ISBN 0590187317

Cole, Joanna and Linda Ward Beech: *The Magic School Bus In the Haunted Museum, A Book About Sound.* Scholastic Trade (1995), ISBN 0590484125

Farndon, John: *Exploring History, Science and Technology.* Lorenz Books (2000), ISBN: 0754804542

Hann, Judith: *How Science Works.* Reader's Digest (1999), ISBN: 0762102497

Kim, Sunnie and Lisa Melton: *Catch a Wave: The Story of Sound and Light.* Science Kids (1999), ISBN: 1891418165

DjiSpezio, Michael: *Awesome Experiments in Light and Sound.* Sterling Publications (2000), ISBN: 0806993111

Clement, Mike: *Light and Sound.* Bbc Pubns (1999), ISBN: 0563375051

Activities and Worksheets

In the Guide

Methods of Science Board 14
Use the flowchart of the scientific method's processes to create a display board to help the students understand the process as the tree house detectives investigate the speed of sound.

Scientific Method Worksheet 15
Match and identify by using the terms of the scientific method.

Colorful Carnations 16
Children use the scientific method to predict, experiment, and draw conclusions about what happens when carnations are placed into colored water.

Mystery Balloons 17
An activity that uses balloons and film canisters to help students understand the difference between an observation and an inference.

Observations and Inferences Worksheet .18
Students practice distinguishing between observations and inferences.

Hot and Cold Water Experiment . . .19
A take-home project to reinforce the student's understanding of the scientific method.

Matrix Board 20
A chart to help students gather and sort data as they view the video.

What Causes Sound? 21
A student worksheet that helps students determine which objects vibrate to create sound.

Word Search 22
A word search highlighting key vocabulary terms.

Vibrations of Sound 23
A teacher handout with numerous activities that are simple and easy to demonstrate or perform by the teacher or the students.

Teacher Answer Key 24
Answer key for all guide and web-based worksheets.

On the Web

You can find the following activities on the Web at http://whyfiles.larc.nasa.gov.

Science Inquiry
An overview of science inquiry that can be used as a teacher resource or a parent handout.

Scientific Method Handout
A brief description of the scientific method.

Scientific Method Check 1
Application of the scientific method for grades 4 and 5.

Scientific Method Check 2
Application of the scientific method for grades 4 and 5.

Color Mixing
Mixing the primary colors by using the scientific method.

Where's That Sound?
Students fine-tune their hearing in pinpointing the location of a sound.

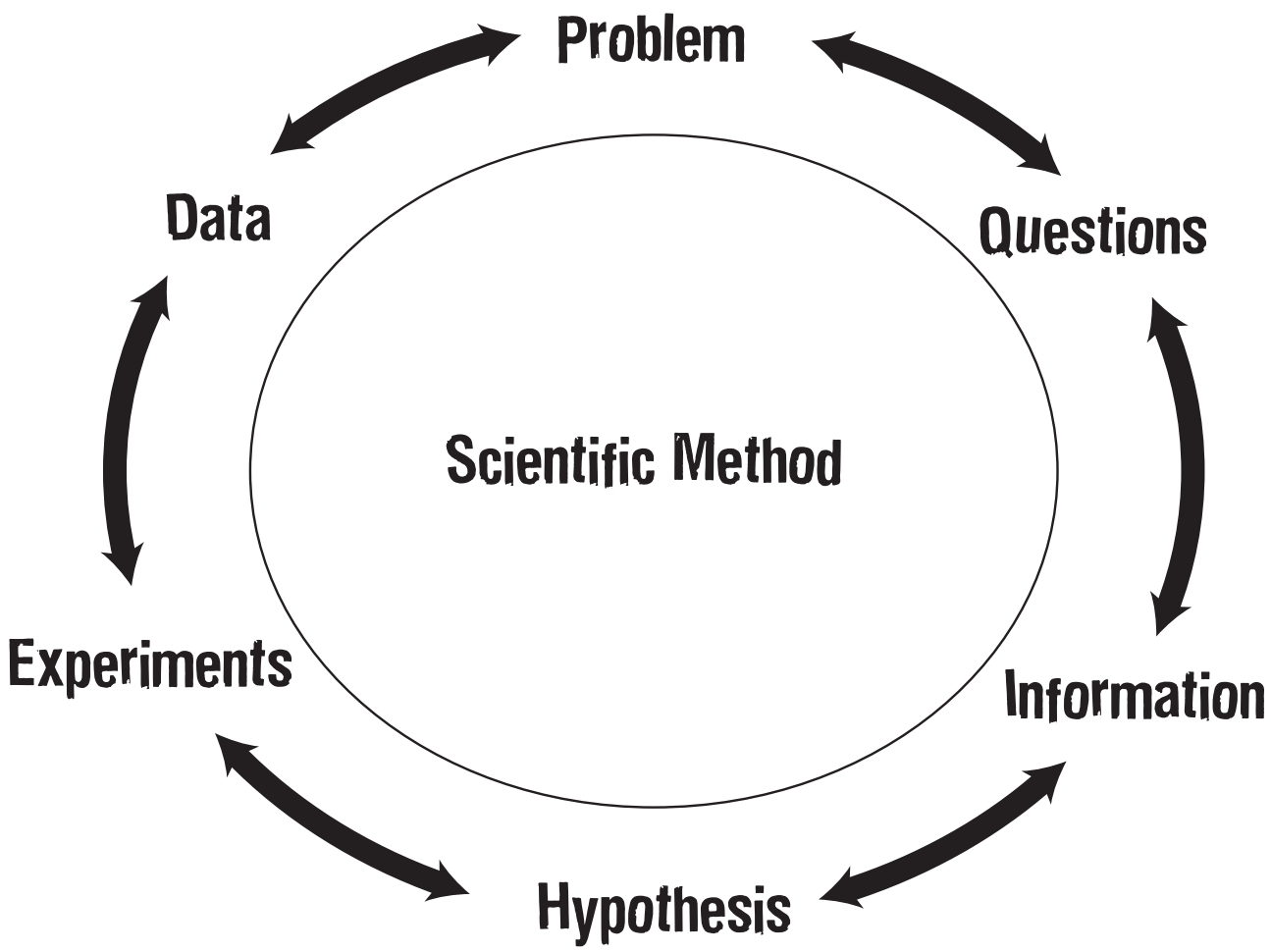
What a Kazoo!
Make a Kazoo and demonstrate the physics of sound and vibration.

Instrument Inventors
Accompanying extension for making a Kazoo. Students will research various musical instruments and their origins.

Methods of Science Board

Create a display board of the following chart and use it to help students understand the processes of the scientific method. Make clear that this is not a step-by-step procedure but rather a flexible process that often changes as information is gathered. For example, if you perform an experiment and your hypothesis is not correct, you may wish to reformulate your problem, do more research, create a new hypothesis, or rewrite your experiment.

To help the students as you view the video, you may wish to write on this chart as the tree house detectives go through the process themselves. Use the board to monitor the tree house detectives' research, hypothesis, and any data they collect. Help the students to see that the tree house detectives often change their hypothesis as the they learn new information.



Scientific Method Worksheet

Match the word with the definition.

A. Problem
B. Research
C. Materials
D. Data
E. Procedure
F. Variable
G. Hypothesis

____1. Looking through books, web sites, or newspapers for information on a topic.

____2. The experiment.

____3. A list of things needed for the experiment.

____4. Always asked as a question.

____5. Observations recorded and put into charts or graphs.

____6. An educated guess as the answer to the problem.

____7. Factor that is changed during an experiment to see what will happen.

8. In the following experiment, which variable is being manipulated (changed)?

Brands A, B, and C of hamburger meat are tested for the amount of fat in each. Each brand will be cooked for exactly 7 minutes. The same pan will be used for each test. The brands will each be drained for exactly 2 minutes by using a strainer and a measuring cup to determine the amount of fat that is drained.

❑ The cooking time

❑ The pan

❑ The brands being tested

❑ The straining of the meat after cooking

Colorful Carnations

Problem How can I add color to white carnations?

Research Suggested topics to research are plants, flowers, stems, color dye, and water movement through a plant.

Hypothesis If I place a carnation into colored water, then the carnation _____ turn that color.
will/will not

Materials

White carnation for each group
Observation Chart
Food coloring
Clock or timer
Pencil
Scissors
Crayons
Beaker
Metric ruler
Jar
Water

Procedure

1. Gather all materials needed for the experiment.
2. Measure 200 ml of water and pour into the jar.
3. Add 5 drops of food color to the water and gently shake.
4. Cut the stem of the carnation diagonally so that the carnation measures approximately 20 cm in length.
5. Place the carnation into the jar and observe.
6. Record your observation on the chart. You will need to draw what you see and write a description of your observations; be sure to use all appropriate senses.
7. Make observations every hour until a change is noticed.
8. Share your results with the other groups and draw conclusions.

Data

Observations	Time: 0:00	1 hour	2 hours	3 hours	4 hours
Drawing of Carnation					
Description of Carnation					

Conclusion My hypothesis was _____.
Correct / not correct

Explain why: _____

_____

_____

Going Beyond Explain what you could have done differently in your experiment to make it better.

Extensions How could you extend this activity?

Mystery Balloons

Purpose

To provide students with experience in making observations and inferences and in determining the difference between them.

Materials

4 black helium balloons per group
materials for filling balloons (flour, sugar, corn, rice)
4 black film canisters with a hole punched in center of each lid per group
objects to put in canisters (rocks, sand, marbles)
toothpick or skewer for each canister (extras may be needed due to breakage)
paper for chart

Procedure

1. Prepare balloons and canisters for students by filling each balloon with a different substance such as flour, sugar, corn meal, or popcorn. Tie off ends. Place different objects in each film canister and secure lid. Place toothpick or skewer in the hole in the center of lid. Students will use these to "feel" the objects.
2. Explain observations and inferences. Observations are made with the five senses. Use as many senses as are appropriate. An inference is like a guess (what you can conclude after your observations).
3. Group students and pass out a set of balloons to each group.
4. Have students observe balloons. Teacher may need to guide students in observations.
5. Have students write their observations on a chart.
6. When students are finished, have them share their observations.
7. Explain that these are all observations.
8. Ask students to guess what is inside each balloon and record guesses on the chart.
9. Have students share their guesses and explain that these are inferences.
10. Tell the students what is inside each balloon.
11. Repeat with the film canisters. Explain that this time you are taking away several of their senses. They no longer have sight and touch is limited by using the toothpick.
12. For a final assessment, you can take a black garbage bag or paper bag and place an item or two in it. Have each student write an observation and an inference.

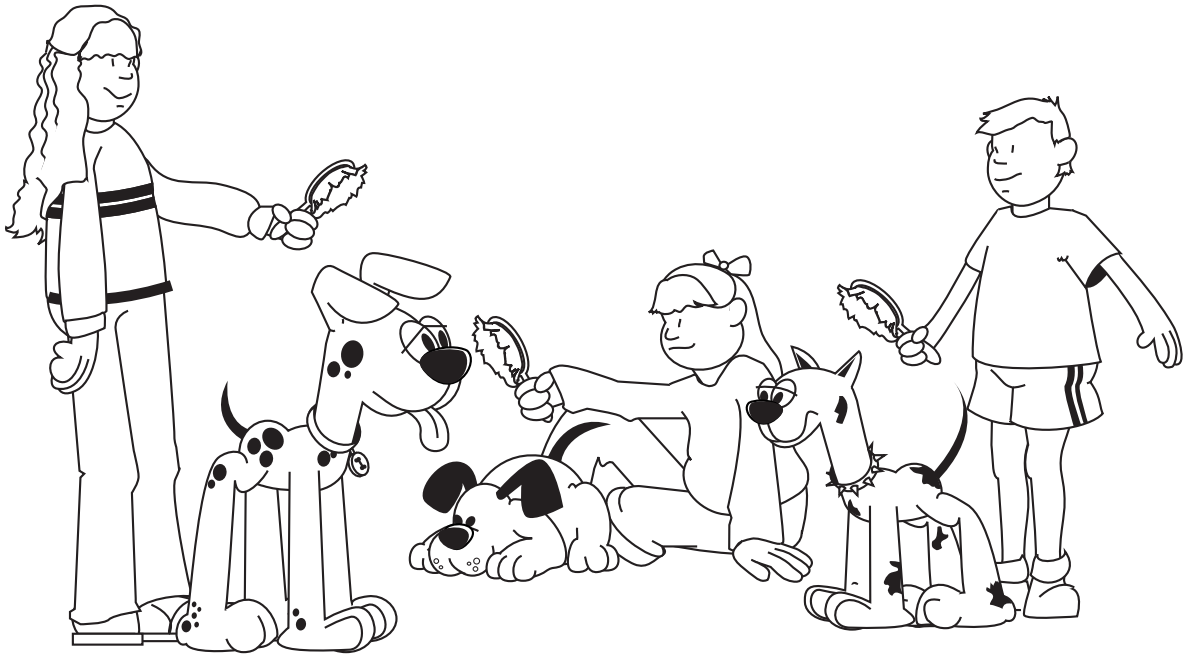
Extensions

1. Use olfactory jars for sense of smell.
2. Take an object and have blindfolded partner make observations and inferences.
3. Provide a mystery bag for students to practice making observations and inferences.

Observations and Inferences

When you perform activities and experiments, you make observations with your five senses; therefore, an observation is something you can see, feel, smell, hear, or taste. There are times when you make judgments or decisions based on logical observations. These judgments or decisions are called inferences. Inferences are logical conclusions based on your observations.

Look at the picture below. Read the statements. Based on what you observe in the cartoon, decide whether each statement is an observation or an inference. Write your choices on the lines.



_____1. Three children are holding a brush.

_____2. The biggest dog is smiling.

_____3. One girl has a bow in her hair.

_____4. All the dogs have ears.

_____5. The dogs are going to get brushed.

_____6. The dogs are all friends.

Make up four inferences or observations of your own (to the right of 7-10). Write the word *observation* or *inference* on the lines to the left to describe each.

_____7. _____

_____8. _____

_____9. _____

_____10._____

Hot and Cold Water Experiment (Take home project.)

Use the following outline to design an experiment to test which will freeze first, hot water or cold water. Be sure to research water and its properties. Factors to keep in mind are how hot is hot, and how cold is cold? You will need to make sure the temperatures are defined. Also, be certain that you have listed all materials you will need for the experiment (as if you are in an empty room). The procedure should be clear and detailed so that anyone can duplicate your experiment with ease. Don't forget your control setup and a list of your variables. Repeated trials are a must! Data should be recorded on a chart. Use the chart information to create a graph for easy display and reading. Finally, be sure to state in the conclusion whether your hypothesis was correct or incorrect. Good luck!

(Title)

Problem Which will freeze first, hot water or cold water?

Research

Hypothesis If I freeze hot and cold water at the same time and in the same size containers, then _____ water will freeze first.

Materials
1. (list form)
2.

Procedure
1. (list form)
2.

Data
Chart
Graph

Conclusion My hypothesis was _____. (Why was it correct or why was it incorrect? Explain.)

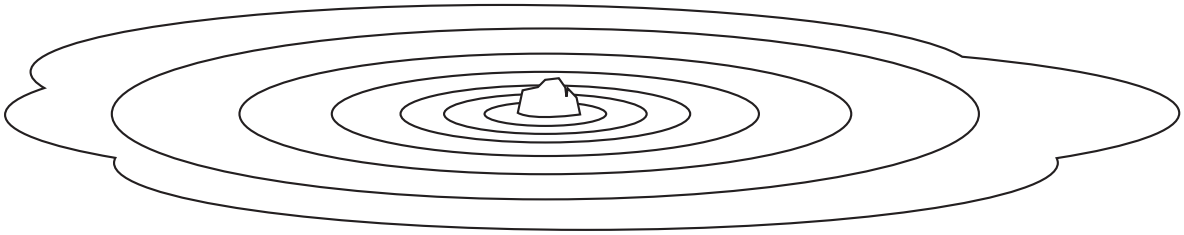
Extension

Going Beyond
What would you do differently next time?
What went right in your experiment?
What went wrong?

Matrix Board

What Causes Sound?

Sound is created by waves. When a stone is thrown into the water, small circles (waves) form and continue to form and spread out beyond the point where the stone entered the water. (See diagram below.) We cannot see sound waves, but we can hear them. Vibration causes sound waves. The vibrating object moves the air, and this movement creates the sound we hear.



Ripples on the water from a stone are like waves created from vibrations in air.

Use your knowledge of objects and vibration to determine what type of object is vibrating to make the following sounds.

_____ 1. A dog barking

_____ 2. A piano playing

_____ 3. A person speaking

_____ 4. A clarinet playing notes

_____ 5. A bell ringing

Think of other sounds and tell what is vibrating to make the sound.

6. _____

_____

_____

_____

_____

_____

Word Search

M W B G F T K M J H Y O P L U A T A D
E E G R F D V B J H Y J U J U J V I U
T H Y P O T H E S I S Y W Q M K I P R
H V C D E L S O G O T K E A M U B D E
O C U Y T R E V A R I A B L E S R R S
D T S K A B H P Q L I N R X L O A R E
S U Y U U I Y O I L K U A R W D T K A
O B V O L I C N B I N C T K E A I S R
F X H U Y R N K H S J U Y H G B O Y C
S R T W H F E V T G E B V C U I N P H
C J S P O S U E K F I R V I U X S D K
I M I B V U Q L P S G E V Y A S H N V
E S T U R H E E H U Y H Y A K G F H I
N D N N B V R R T Y U O L K T G F D X
C F E H K G F L K J H F L A K I J D L
E O I N M N V F O I U Y E A P H O Q K
H N C E D B C N K Z D F C X K I L N T
R T S C I E N T I F I C M E T H O D G
V C X S K P O Z W Q D J H G M K I K H
D L K M N C U K Y T J R E W Q G H J Q
F R T Y D S C O N C L U S I O N Y G Y

conclusion
data
frequency
hypothesis
methods of science
observation
research
scientific method
scientist
variables
vibrations

Vibrations of Sound Activities and Demonstrations

These activities can be used by the teacher or at home to help teach and reinforce the concepts and objectives of this segment. These activities can be explored and used to encourage learning through investigation.

1. Hold one end of a rubber band between your teeth. Pull the other end a little but not enough to break it. Pluck it. What vibrates?

2. Strike a tuning fork. Dip its prongs into a glass of water. What do you observe?

3. Suspend a cork on a string so it can move freely. Strike the tuning fork and hold the prongs against the cork. What happens?

4. Tie several pieces of silverware close together on a string. Hold the two ends of the string to your ears. Have someone tap the utensils so they bump together. What do you hear?

5. Place several grains of rice or seeds on the surface of a can or box. Strike the container with a ruler. What do you observe? Try different size cans or boxes. Do the sounds vary? Do the seeds behave differently?

6. Inflate a balloon. Hold it lightly near your lips as you speak. Speak loudly. Speak more softly. What did you notice?

7. Set an alarm clock. Let it ring while it is sitting on a solid surface such as a desk. Describe the sound. Let it ring again while it is sitting on a rug or other soft surface. How did the sound change? Why did it change?

8. Strike a tuning fork and gently touch its prongs against the side of a glass. What happens?

9. Strike a tuning fork. Hold it near your ear. Touch the tuning fork. What did you feel? What did you hear?

10. Strike a tuning fork. Place the tip of the fork in a small bowl of water. What happened to the water? Why did this occur?

Teacher Answer Key

Scientific Method Worksheet

1. B
2. E
3. C
4. A
5. D
6. G
7. F
8. the brand being tested

Observation and Inferences

1. Observation
2. Inference
3. Observation
4. Observation
5. Inference
6. Inference

7-10 Answers will vary

What Causes Sound?

vocal chords
strings
vocal chords
wooden reed on clarinet
metal that surrounds the bell
6-10 Answers will vary

Word Find